



# ***Lunar Surface Innovation Consortium: Regolith to Rebar Workshop***

**Feb. 23, 2022**

**EXPLORESpace TECH**  
TECHNOLOGY DRIVES EXPLORATION

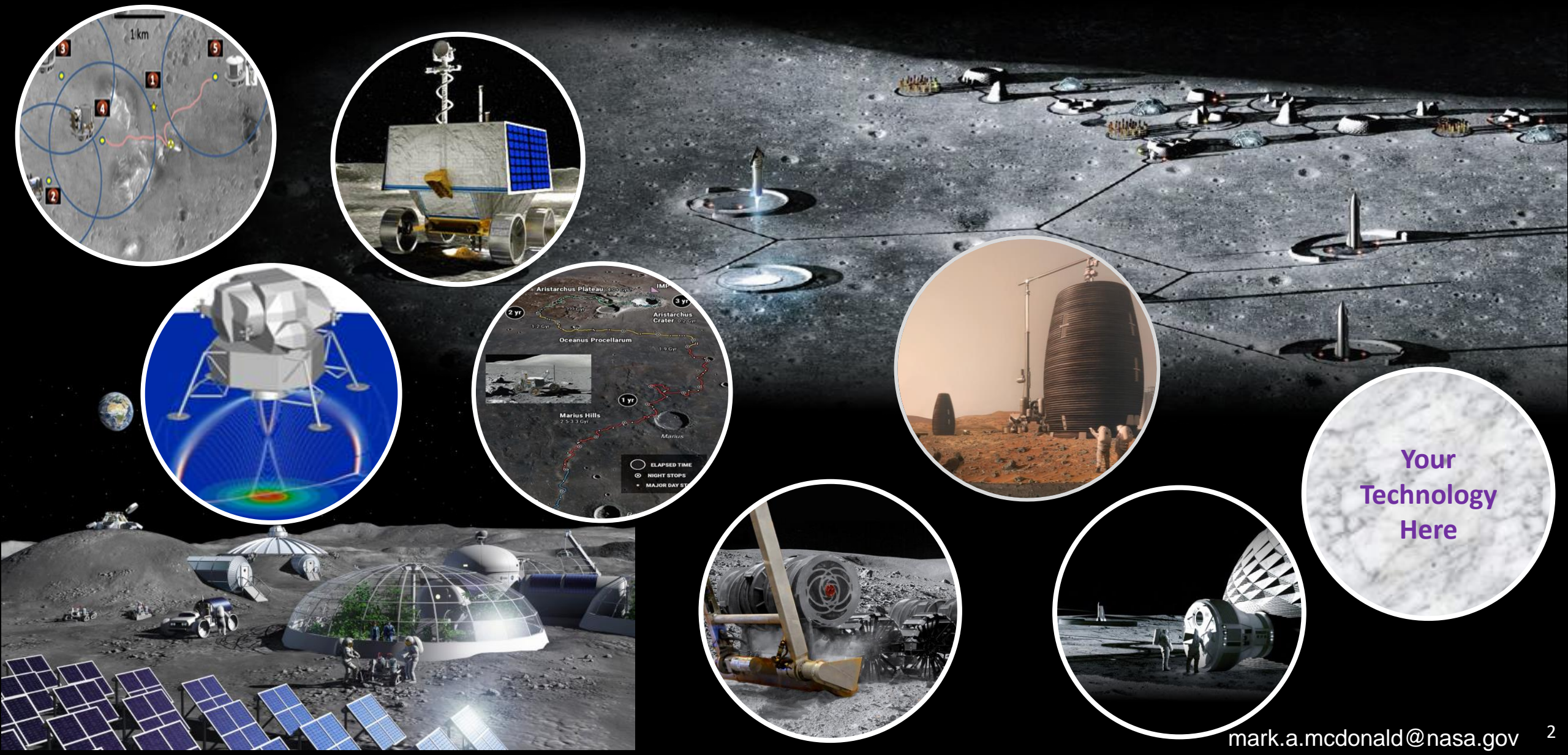
## ***NASA's Vision for the Lunar Surface***

**Mark McDonald**





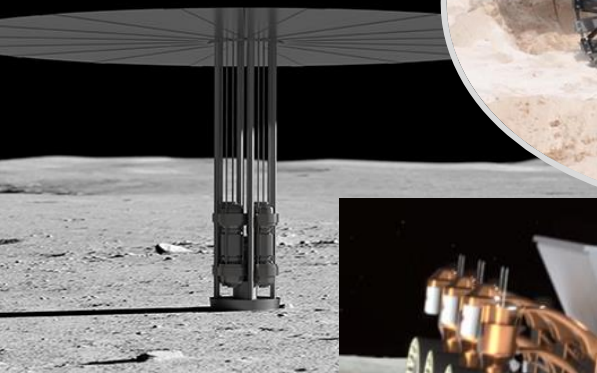
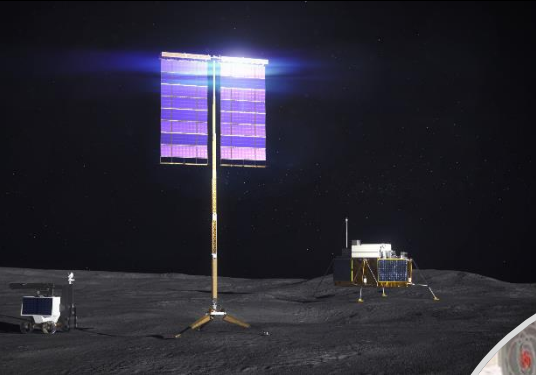
# Objective: Develop the technologies for global lunar utilization and enable continuous lunar human and robotic operations.



Your  
Technology  
Here








# Regolith to Rebar: Multifaceted Problem





# NASA's Envisioned Future Priority Packages

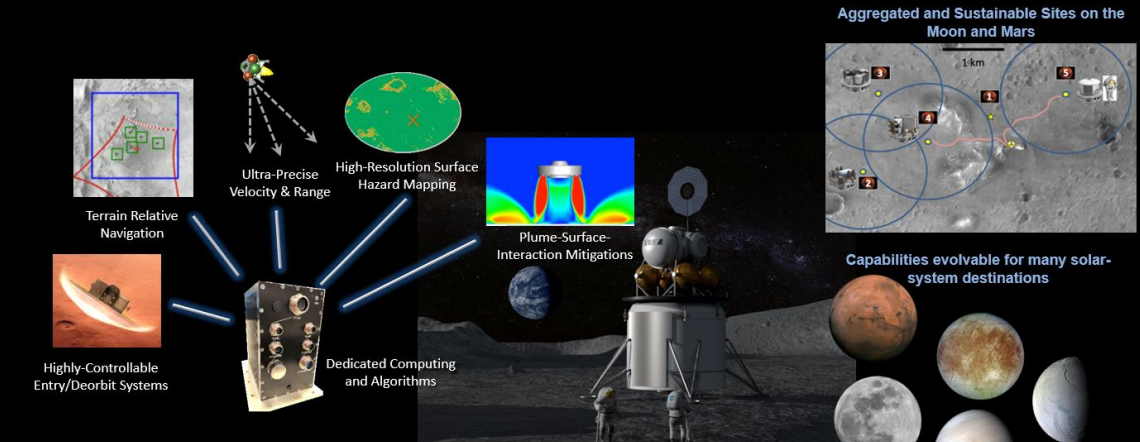


Lead	Thrusts	Outcomes
 <b>Ensuring American global leadership in Space Technology</b> <ul style="list-style-type: none"><li>Advance US space technology innovation and competitiveness in a global context</li><li>Encourage technology driven economic growth with an emphasis on the expanding space economy</li><li>Inspire and develop a diverse and powerful US aerospace technology community</li></ul>	 <b>Go</b> Rapid, Safe, and Efficient Space Transportation	<ul style="list-style-type: none"><li>Develop nuclear technologies enabling fast in-space transits.</li><li>Develop cryogenic storage, transport, and fluid management technologies for surface and in-space applications.</li><li>Develop advanced propulsion technologies that enable future science/exploration missions.</li></ul>
	 <b>Land</b> Expanded Access to Diverse Surface Destinations	<ul style="list-style-type: none"><li>Enable Lunar/Mars global access with ~20t payloads to support human missions.</li><li>Enable science missions entering/transiting planetary atmospheres and landing on planetary bodies.</li><li>Develop technologies to land payloads within 50 meters accuracy and avoid landing hazards.</li></ul>
	 <b>Live</b> Sustainable Living and Working Farther from Earth	<ul style="list-style-type: none"><li>Develop exploration technologies and enable a vibrant space economy with supporting utilities and commodities</li><li>Sustainable power sources and other surface utilities to enable continuous lunar and Mars surface operations.</li><li>Scalable ISRU production/utilization capabilities including sustainable commodities on the lunar &amp; Mars surface.</li><li>Technologies that enable surviving the extreme lunar and Mars environments.</li><li>Autonomous excavation, construction &amp; outfitting capabilities targeting landing pads/structures/habitable build</li><li>Enable long duration human exploration missions with Advanced Habitation System technologies. [Low TRL STMD]</li></ul>
	 <b>Explore</b> Transformative Missions and Discoveries	<ul style="list-style-type: none"><li>Develop next generation high performance computing, communications, and navigation.</li><li>Develop advanced robotics and spacecraft autonomy technologies to enable and augment science/exploration missions</li><li>Develop technologies supporting emerging space industries including: Satellite Servicing &amp; Assembly, In Space/Surface Spacecraft technologies.</li><li>Develop vehicle platform technologies supporting new discoveries.</li><li>Develop technologies for science instrumentation supporting new discoveries. [Low TRL STMD/Mid-High TRL STMD]</li></ul>

- NASA's Envisioned Future for each Strategic Outcome
- NASA's understanding of the State of the Art
- NASA's near-term high priorities relative to each outcome

## LAND: Technologies to Precisely Land Payloads and Avoid Landing Hazards

Developing entry, descent and landing technology to enhance and enable small spacecraft to Flagship-class missions across the solar system



- Enable anytime landings in treacherous terrains and independent of lighting
- Reduce the risk of the landing for human and robotic missions to many destinations
- Reduce operations time for a rover or human to reach an interesting site
- Aggregate resources in one surface region for missions requiring multiple landings



# Request For Information (RFI) Release Plan








Target Release Timeframe	Thrust Category	Likely Topic Areas
Q1-Q2 (~March → May)	GO	<ul style="list-style-type: none"><li>• Cryogenic fluid storage, transport, management</li><li>• Advanced (non-nuclear) propulsion</li></ul>
Q2-Q3 (~June → August)	LIVE	<ul style="list-style-type: none"><li>• Sustainable power sources for continuous lunar surface operations</li><li>• Scalable In-Situ Resource Utilization (ISRU) for lunar</li><li>• Autonomous excavation, construction and outfitting leveraging ISRU</li><li>• Long duration human exploration technologies</li></ul>
Q3-Q4 (~September → December)	EXPLORE	<ul style="list-style-type: none"><li>• Next generation high performance computing</li><li>• Advanced robotics and spacecraft autonomy</li><li>• Satellite servicing and assembly, surface assembly, in space/surface manufacturing</li></ul>
Q3-Q4 (~September → December)	LAND	<ul style="list-style-type: none"><li>• Lunar global access for ~20t payloads for human missions</li><li>• Precision landing, 50m accuracy or better while avoiding hazards</li></ul>



# NASA's Envisioned Future Priority Packages



Lead	Thrusts	Outcomes
 <p><b>Ensuring American global leadership in Space Technology</b></p> <ul style="list-style-type: none"> <li>• Advance US space technology innovation and competitiveness in a global context</li> <li>• Encourage technology driven economic growth with an emphasis on the expanding space economy</li> <li>• Inspire and develop a diverse and powerful US aerospace technology community</li> </ul>	 <p><b>Go</b> Rapid, Safe, and Efficient Space Transportation</p>	<ul style="list-style-type: none"> <li>• Develop nuclear technologies enabling fast in-space transits.</li> <li>• Develop cryogenic storage, transport, and fluid management technologies for surface and in-space applications.</li> <li>• Develop advanced propulsion technologies that enable future science/exploration missions.</li> </ul>
	 <p><b>Land</b> Expanded Access to Diverse Surface Destinations</p>	<ul style="list-style-type: none"> <li>• Enable Lunar/Mars global access with ~20t payloads to support human missions.</li> <li>• Enable science missions entering/transiting planetary atmospheres and landing on planetary bodies.</li> <li>• Develop technologies to land payloads within 50 meters accuracy and avoid landing hazards.</li> </ul>
	 <p><b>Live</b> Sustainable Living and Working Farther from Earth</p>	<ul style="list-style-type: none"> <li>• Develop exploration technologies and enable a vibrant space economy with supporting utilities and commodities                             <ul style="list-style-type: none"> <li>• Sustainable power sources and other surface utilities to enable continuous lunar and Mars surface operations.</li> <li>• Scalable ISRU production/utilization capabilities including sustainable commodities on the lunar &amp; Mars surface.</li> <li>• Technologies that enable surviving the extreme lunar and Mars environments.</li> <li>• Autonomous excavation, construction &amp; outfitting capabilities targeting landing pads/structures/habitable buildings utilizing in situ resources.</li> </ul> </li> <li>• Enable long duration human exploration missions with Advanced Habitation System technologies. [Low TRL STMD; Mid-High TRL SOMD/ESDMD]</li> </ul>
	 <p><b>Explore</b> Transformative Missions and Discoveries</p>	<ul style="list-style-type: none"> <li>• Develop next generation high performance computing, communications, and navigation.</li> <li>• Develop advanced robotics and spacecraft autonomy technologies to enable and augment science/exploration missions.</li> <li>• Develop technologies supporting emerging space industries including: Satellite Servicing &amp; Assembly, In Space/Surface Manufacturing, and Small Spacecraft technologies.</li> <li>• Develop vehicle platform technologies supporting new discoveries.</li> <li>• Develop technologies for science instrumentation supporting new discoveries. [Low TRL STMD/Mid-High TRL SMD. SMD funds mission specific instrumentation (TRL 1-9)]</li> <li>• Develop transformative technologies that enable future NASA or commercial missions and discoveries</li> </ul>